2224

PHYTOTOXICOLOGY VEGETATION ASSESSMENT SURVEYS - TONOLLI COMPANY OF CANADA LTD., MISSISSAUGA: 1986 TO 1991

DECEMBER 1992

Ontario

Environment
Environnement

16/12/92

ISBN 0-7778-0339-9

PHYTOTOXICOLOGY VEGETATION ASSESSMENT SURVEYS - TONOLLI COMPANY OF CANADA LTD., MISSISSAUGA: 1986 TO 1991

DECEMBER 1992

Cette publication technique
n'est disponible qu'en anglais.

Log 92-2231-039
PIBS 2226

PHYTOTOXICOLOGY VEGETATION ASSESSMENT SURVEYS - TONOLLI COMPANY OF CANADA LTD., MISSISSAUGA: 1986 TO 1991

Report prepared by:
R. Emerson

Phytotoxicology Section
Air Resources Branch
Ontario Ministry of the Environment

DECEMBER 1992

Log 92-2231-039
PIBS 2226

Phytotoxicology Vegetation Assessment Surveys - Tonolli Company of Canada Ltd., Mississauga: 1986-1991

Introduction

The Phytotoxicology Section has surveyed lead contamination of vegetation and/or soil in the vicinity of Tonolli Company of Canada Ltd., 1333 Tonolli Road, Mississauga, annually since 1970, 1988 being the only exception. Tonolli is the only secondary lead smelter that is currently operating in the survey area. The Exide Canada smelter, which was situated just east of the intersection of Dixie Road/Queensway Avenue, closed in August 1986. The surveys were requested by MOE Central Region, Halton-Peel District. This report presents the results of the most recent tree foliage surveys that were conducted in the vicinity of Tonolli from 1986 to 1991.

Previous surveys in 1985 and earlier revealed that foliar concentrations of lead had increased in the survey area for four consecutive years, from 1982 to 1985. In July 1987, the Tonolli company was served with a control order by the MOE. The company, since 1987, has enclosed processing areas (crushing, mixing and delivery rooms) and the furnace lead smelting area. As a further measure to reduce particulate lead emissions, ventilation and dust collection systems have been improved/installed. In addition, traffic areas are kept wet and vehicles are washed before leaving the property. In June of 1990, the control order was rescinded.

Historical lead emissions from both Tonolli and Exide have resulted in soil contamination in the area. From 1987 to 1989, Phytotoxicology staff conducted extensive soil sampling throughout the neighbouring residential area (south of Queensway Ave.) to identify properties with soil lead concentrations greater than the MOE residential soil replacement level (500 ug/g). Numerous sites also were sampled in the commercial area (north of Queensway). These results have been reported previously. In the fall of 1990, a soil replacement program was conducted in the residential area. Surface soil with 500 ug/g or more lead was replaced on affected residential properties, east and west of Dixie Road. In the fall of 1991, surface soil also was replaced on contaminated (publicly accessible) boulevards bordering Dixie Road and Queensway Avenue in the commercial area.

Field Surveys

Tree foliage was collected from the survey area in all years (1986-1991), except 1988. Each year (September), foliage was collected at about 40 sites from middle branches facing Tonolli, using standard sampling procedures. In 1986 and 1987, Austrian pine needles (current year) were collected at Sites 17 and 19 from both the side facing Tonolli and the side facing Exide. In 1989, Site 17 was discontinued and Norway maple foliage

(rather than pine needles) was collected in the area of Site 19. In 1989, there was also a change in tree species at some other sites, as noted in Table 1. The tree at Site 45 has been cut down and was not replaced in 1991. Surface soil was collected at these sampling sites in previous years, but not from 1986 to 1991. The foliage collection sites are shown in Figure 1.

The foliage samples were returned to the Phytotoxicology Laboratory. Here, the samples were oven dried, ground and stored in glass jars. They were then submitted to the MOE Laboratory Services Branch for analysis of lead, arsenic, antimony and cadmium, all of which are potential components of emissions from Tonolli and Exide.

Results and Discussion

Lead

The foliar lead results for 1986 to 1991 are presented and compared to previous survey (1981-1985) results in Tables 1 and 2. Table 1 shows the lead concentrations at all foliage sites and those that exceeded the Phytotoxicology Upper Limit of Normal (ULN) urban guideline (60 ug/g) each year. Table 2 shows the lead results for only the common maple sites that were sampled from 1981 to 1991. Each year (1986-1991), the highest concentrations of lead were detected at Site 1 in the vicinity of Tonolli's north property limit. From 1986 to 1991, lead concentrations at Site 1 ranged from 405 to 1950 ug/g. Foliar lead concentrations at other sites were markedly lower and displayed a decreasing concentration gradient with increasing distance from Tonolli.

In 1986, foliar lead concentrations declined at about 55% of all foliage sites compared to the previous years. However, at sites close to Tonolli, foliar lead concentrations, overall, were slightly higher in 1986 than in 1985. Concentrations at maple sites in the immediate area of Tonolli (<400 m) also were increased in 1987, with maple Site 1 (1950 ug/g) having the highest foliar lead concentration detected during the 10 year period (1981-1991). This clearly shows the significance of Tonolli as opposed to Exide as the primary lead source in the area. This is further evidenced by the results of the two-sided pine needle sampling (Table 5) and by the extent to which lead concentrations in tree foliage were still elevated (>60 ug/g) in 1987, subsequent to the closure of Exide (August 1986). In 1987, elevated foliar lead concentrations greater than the ULN (60 ug/g) were measured at distances up to 820 m E, 490 m S, 350 m W and 480 m NW of the Tonolli. However, common maple sites between 400 and 800 m from Tonolli (400-800 m), several of which were closer to Exide, did show a slight decrease in mean lead concentration in 1987 (61 ug/g) compared to 1986 (95 ug/g). At Site 58, directly across from Exide, the foliar lead content of the foliage declined from 240 ug/g in 1986 to 102 ug/g in 1987. The closure of Exide had unquestionably contributed.

In 1989, 1990 and 1991, foliar lead concentrations throughout the survey area declined, with the 1991 results (range 2-405 ug/g) being the lowest at 37 of the 40 sample sites.

At common maple sites within 400 m of Tonolli, the mean lead concentration decreased from 781 ug/g in 1987 to 149 ug/g in 1991 (see Figure 2). This figure shows that lead concentrations in tree foliage also have decreased over the larger area (>400 m) in recent years (1989-1991). Exceedances of the 60 ug/g ULN guideline also have decreased since 1987. The ULN was exceeded at 4 sites in 1991 and at 7 sites in both 1990 and 1989. This is a significant reduction compared to 16 sites in 1987, 20 in 1986 and 25 in 1985. Since 1987, foliar lead concentrations in the residential area (S of Queensway) have been below the 60 ppm ULN. In recent years (1989-1991), elevated lead concentrations (>60 ug/g) were found only at sites in the commercial area (N of the Queensway).

The phase-out of leaded gasoline since the mid-1980s and the complete ban in December 1990 has likely contributed to the reduction in foliar lead levels in recent years. As Exide has closed (1986) and as lead has been banned from gasoline (1990), the foliar results for 1991 (lowest ever detected) reflect only the lead contribution from Tonolli emissions plus re-entrainment. In 1983, it was estimated, using concentration ratios of tracer elements in surface soil and foliage, that re-entrainment could account for an average of 10% of the lead in tree foliage collected at the Tonolli/Exide sampling stations. However, the contribution from re-entrainment would diminish with time. The contribution from root uptake of lead in the soil also would be expected to be very minor, on the basis of the literature. A few more years of data will determine if foliar lead concentrations in the survey area have stabilized.

Arsenic, Antimony, Cadmium

Tables 3 and 4 show the arsenic and antimony results from 1986 to 1991. Similar to lead, arsenic and antimony concentrations each year were the highest at Site 1 and decreased with increasing distance from Tonolli. The cadmium results, which revealed a similar pattern, are not presented as non-quantifiable concentrations were detected at at the majority of sites and no ULN exceedances occurred. Even the highest cadmium concentrations (range 0.7-1.3 ug/g at Site 1) did not exceed the ULN (2 ug/g). Since 1987, the ULN for arsenic (2 ug/g) has been marginally exceeded only at Site 1. Antimony concentrations are still appreciably greater than the ULN (0.5 ppm) at sites close to Tonolli. However, arsenic and antimony, similar to lead, displayed a reduction in foliar concentrations and in the number of exceedances of the ULN in recent years (1989-1991) compared to 1987 and earlier. As with lead, the greatest reduction has occurred at sites closest to Tonolli (see Figures 2 to 4). These findings were not unexpected, as statistical analysis of the 1987 data revealed that concentrations of arsenic, antimony and cadmium were significantly correlated (0.1% level) with the lead results.

Air Monitoring Results

Figure 5 shows the annual mean concentration of lead in dustfall for 1981 to 1991 (June

to September) for the 3 dustfall stations (46041, 46045, 46046) within 400 m of Tonolli versus the 3 stations (46008, 46009, 46011 - >400 m) in the residential area, more remote from Tonolli. Figure 6 shows the corresponding annual means for lead in total suspended particulate for the 3 close stations. These are the only hi-vol stations in the survey area (see Figure 1). Figures 5 and 6 show that lead concentrations in dustfall and suspended particulate in the ambient air in 1986 and 1987 were similar to previous years. However, at air monitoring stations closest to Tonolli (<400 m), the mean lead concentration (June-September) in both dustfall and suspended particulate has decreased for 5 consecutive years (1987-1991) since 1986. In recent years (June-September), there has also been a decline in the number of exceedances of the MOE Ambient Air Quality Criteria for lead in dustfall and suspended particulate (see Table 6 below). The AAQCs for suspended particulate (both arithmetic and geometric 30 day means) have not been exceeded since 1988. These results correspond fairly well with the foliage data and further show that air quality in the survey area has improved considerably since the Tonolli control order (1987), and did not deteriorate after it was rescinded in 1990.

Table 6: Number of Times the Ambient Air Quality Criteria (AAQC) for Lead in Dustfall and Suspended Particulate were Exceeded at the Six Air Monitor Stations Near Tonolli: June-September, 1986-1991

Year	Number of Times AAQC Exceeded (June-Sept.)	
	Dustfall (All Stations)	Suspended Particulate (Three Close Stations)*
1986	6	8
1987	7	4
1988	4	4
1989	1	0
1990	1	0
1991	0	0

AAQC for lead in dustfall - 0.1 $g/m^2/30$ days
AAQC for lead in suspended particulate - 3 $ug/m^3/30$ days * see Figure 1

Conclusion

The foliage surveys (1986-1991) revealed that sites near Tonolli still exceeded the ULN guidelines for lead, arsenic and antimony. In all of these cases, foliar concentrations were the highest in the immediate area of Tonolli. However, from 1989 to 1991, foliar

concentrations of lead, arsenic and antimony in the survey area declined markedly from the relatively elevated concentrations in 1987 and earlier years, particulary at sites closest to Tonolli. These results, together with the air monitoring data, indicate that there has been a significant improvement in air quality in the survey area. Foliar lead levels in 1991 were the lowest detected in the survey area. A few more years of data will determine if Tonolli emissions have stabilized. This improvement in air quality can be attributed to the closure of Exide, abatement activities and/or the control order on Tonolli, and the phase-out/ban of leaded gasoline.

Table 1: Concentrations of Lead in Tree Foliage in Vicinity of Tonolli, Mississauga: 1981-1991

Site No.	Distance & Direction from Tonolli	Species	Lead Concentration*									
			1981	1982	1983	1984	1985	1986	1987	1989	1990	1991
1	80 m NW	Silver maple	990	572	850	925	900	1300	1950	965	1055	405
3	300 m NW	Silver maple	294	109	170	300	270	240	275	155	140	60
4	480 m NW	Silver maple	58	43	62	110	71	120	81	61	53	25
9	370 m N	Elm**	56	42	NR	125	77	42	52	43	38	14
12	200 m NE	Nor. maple**	266	131	490	825	625	535	670	80	175	130
14	500 m NE	Apple	43	57	57	155	139	130	59	39	29	15
15	745 m NE	Elm**	28	28	57	48	70	32	17	9	19	14
18	290 m E	Silver maple	440	107	360	595	845	480	625	125	170	119
19	105 m SE	Nor. maple**	NR	NR	NR	NR	NR	NR	NR	230	390	170
25	240 m S	Ash	760	167	440	435	400	340	180	150	220	56
27	490 m S	Apple	284	120	97	110	150	210	115	67	70	54
28	820 m S	Apple	31	34	33	30	76	49	33	8	8	9
29	1080 m S	Silver maple	18	26	20	12	32	16	40	20	27	12
30	230 m SW	Ash	121	91	75	66	94	99	140	57	60	49
36	350 m W	Man. maple	70	42	30	26	61	140	275	30	46	15
38	790 m W	Elm	45	22	39	28	35	53	50	22	32	9
42	520 m N	Ash**	49	43	42	64	88	79	44	20	15	5
45	420 m E	Elm**	108	85	90	100	210	55	58	15	20	NR
49	495 m E	Honey locust	314	214	130	110	90	98	125	24	32	19
50	640 m E	Nor. maple	45	30	47	54	61	41	40	10	13	9
51	820 m E	Elm	56	47	72	91	102	68	83	17	26	11
52	895 m E	Nor. maple	18	17	14	16	26	15	22	5	7	3
54	615 m E	Nor. maple	49	31	37	60	66	52	71	12	34	6
55	895 m E	Nor. maple**	NR	NR	NR	NR	NR	NR	NR	9	10	6
56	1095 m E	Nor. maple	21	14	14	20	26	18	16	7	5	4
57	1210 m E	Sugar maple	7	10	8	17	8	5	13	4	3	2
58	510 m E	Silver maple	326	142	300	395	116	240	102	31	47	24
59	610 m E	Nor. maple	67	35	29	80	63	62	49	14	18	15
60	650 m SE	Silver maple	97	66	47	80	68	140	72	21	19	17
61	830 m SE	Nor. maple	31	18	15	24	22	44	25	7	6	8
62	960 m SE	Nor. maple	40	NR	33	29	34	22	24	7	6	3
64	480 m SE	Nor. maple	58	33	36	66	70	110	78	17	27	11
65	570 m SE	Sugar maple	71	38	49	57	48	62	44	18	27	11
66	600 m S	Ash	31	16	15	27	33	33	21	11	19	5
67	775 m S	Nor. maple	40	19	13	20	27	31	16	10	15	6
68	350 m SE	Ash	81	91	68	97	190	230	190	43	54	31
71	630 m S	Apple	54	22	29	37	74	62	22	32	15	12
72	840 m S	Man. maple	31	13	11	11	24	13	15	6	7	2
73	575 m SW	Nor. maple	NR	NR	NR	NR	NR	NR	13	8	8	4
74	910 m E	Silver maple	NR	NR	NR	NR	NR	NR	27	7	12	6

* ug/g, dry weight, mean of duplicate samples and analysis 1987-1991. Single or triplicate samples were collected in previous years

** different species sampled prior to 1989

NR - not sampled/no results

Note: Values underlined exceed Phytotoxicology "Upper Limit of Normal" urban guideline (60 ppm), see appendix

Table 2: Foliar Concentrations of Lead at Common Maple Sites: 1981-1991

Site No.	Distance & Direction from Tonolli	Species	Lead Concentration*									
			1981	1982	1983	1984	1985	1986	1987	1989	1990	1991
Closest Sites Within 400 m of Tonolli												
1	80 m NW	Silver maple	990	572	850	925	900	1300	1950	965	1055	405
3	300 m NW	Silver maple	294	109	170	300	270	240	275	155	140	60
18	290 m E	Silver maple	440	107	360	595	845	480	625	125	170	119
36	350 m W	Man. maple	70	42	30	26	61	140	275	30	46	15
		Mean	**449**	**207**	**352**	**461**	**519**	**540**	**781**	**318**	**352**	**149**
Sites Between 400 and 800 m												
4	480 m NW	Silver maple	58	43	62	110	71	120	61	61	53	25
50	640 m E	Norway maple	45	30	47	54	61	41	40	10	13	9
54	615 m E	Norway maple	49	31	37	60	66	52	71	12	34	6
58	510 m E	Silver maple	326	142	300	395	116	240	102	31	47	24
59	610 m E	Norway maple	67	35	29	80	63	62	49	14	18	15
60	650 m SE	Silver maple	97	66	47	80	68	140	72	21	19	17
64	480 m SE	Norway maple	58	33	36	66	70	110	78	17	27	11
65	570 m SE	Sugar maple	71	38	49	57	48	62	44	18	27	11
67	775 m S	Norway maple	40	19	13	20	27	31	18	10	15	6
		Mean	**90**	**49**	**69**	**102**	**66**	**95**	**61**	**22**	**28**	**14**
Sites Greater than 800 m of Tonolli												
29	1080 m S	Silver maple	18	26	20	12	32	18	40	20	27	12
52	895 m E	Norway maple	18	17	14	16	26	15	22	5	7	3
56	1095 m E	Norway maple	21	14	14	20	26	18	16	7	5	4
57	1210 m E	Sugar maple	7	10	8	17	8	5	13	4	3	2
61	830 m SE	Norway maple	31	18	15	24	22	44	25	7	8	8
62	960 m SE	Norway maple	40	NR	33	29	34	22	24	7	6	3
72	840 m S	Man. maple	31	13	11	11	24	13	15	6	7	2
		Mean	**24**	**14**	**16**	**18**	**25**	**19**	**22**	**8**	**9**	**5**

* ug/g, dry weight NR - not sampled/no results Note: Underlined values exceed ULN guideline of 60 ug/g (see appendix)

Table 3: Concentrations of Arsenic in Tree Foliage in Vicinity of Tonolli, Mississauga: 1986-1991

Site No.	Distance & Direction from Tonolli	Species	Arsenic Concentration*				
			1986	1987	1989	1990	1991
1	80 m NW	Silver maple	5.8	10.0	3.7	2.6	2.2
3	300 m NW	Silver maple	1.5	2.2	0.7	0.6	0.4
4	480 m NW	Silver maple	0.6	0.7	0.4	0.4	0.3
9	370 m N	Elm**	0.4	0.4	0.3	0.3	0.2
12	200 m NE	Nor. maple**	1.7	3.3	0.4	0.6	0.9
14	500 m NE	Apple	0.6	0.6	0.5	0.4	0.6
15	745 m NE	Elm**	0.2	0.2	0.2	0.3	0.4
18	290 m E	Silver maple	1.9	4.2	0.6	0.6	0.9
19	105 m SE	Nor. maple**	NR	NR	0.9	1.2	1.2
25	240 m S	Ash	1.5	1.6	0.7	0.9	0.6
27	490 m S	Apple	1.3	0.6	0.6	0.3	0.4
28	820 m S	Apple	0.4	0.3	0.3	0.3	0.2
29	1080 m S	Silver maple	0.2	0.8	0.4	0.4	0.4
30	230 m SW	Ash	0.6	1.0	0.4	0.4	0.4
36	350 m W	Man. maple	1.1	1.3	0.3	0.4	0.3
38	790 m W	Elm	0.4	0.4	0.3	0.3	0.2
42	520 m N	Ash**	0.7	0.7	0.3	0.3	0.2
45	420 m E	Elm**	0.2	2.0	0.3	0.2	NR
49	495 m E	Honey locust	0.6	0.7	0.3	0.5	<0.2
50	640 m E	Norway maple	0.2	0.5	0.2	0.5	0.2
51	820 m E	Elm	0.4	0.6	0.3	0.3	0.3
52	895 m E	Norway maple	0.3	0.3	0.2	0.2	0.2
54	615 m E	Norway maple	0.4	0.7	0.3	0.3	0.3
55	895 m E	Nor. maple**	0.8	0.9	0.4	0.4	0.7
56	1095 m E	Norway maple	1.2	1.8	0.7	0.8	0.9
57	1210 m E	Sugar maple	0.4	0.4	0.3	0.4	0.4
58	510 m E	Silver maple	0.8	0.6	0.3	0.3	0.2
59	610 m E	Norway maple	0.5	0.5	0.3	0.3	0.3
60	650 m SE	Silver maple	0.7	0.6	0.3	0.3	0.4
61	830 m SE	Norway maple	0.7	0.4	0.5	0.6	0.3
62	960 m SE	Norway maple	0.3	0.3	<0.2	0.3	0.4
64	480 m SE	Norway maple	0.8	0.7	0.5	0.4	0.8
65	570 m SE	Sugar maple	1.7	2.0	1.1	1.0	1.7
66	600 m S	Ash	0.6	0.3	0.4	0.3	0.4
67	775 m S	Norway maple	0.4	0.3	0.3	<0.2	0.2
68	350 m SE	Ash	1.8	2.1	0.4	0.4	0.3
71	630 m S	Apple	0.7	0.3	0.5	0.3	0.3
72	840 m S	Man. maple	0.2	0.3	0.3	0.2	0.3
73	575 m SW	Norway maple	NR	0.3	0.3	<0.2	0.2
74	910 m E	Silver maple	NR	0.3	0.3	0.3	0.2
		Analytical Detection Limit	0.2				

* ug/g, dry weight, mean of duplicate (1987-1991) samples and analysis. Single samples were collected in 1986
** different species sampled prior to 1989
NR - not sampled
Note: Values underlined exceed Phytotoxicology "Upper Limit of Normal" urban guideline (2 ppm), see appendix
Nor = Norway, Man = Manitoba

Table 4: Concentrations of Antimony in Tree Foliage in Vicinity of Tonolli, Mississauga: 1986-1991

Site No.	Distance & Direction from Tonolli	Species	Antimony Concentration*				
			1986	1987	1989	1990	1991
1	80 m NW	Silver maple	39.0	61.0	19.0	26.0	21.0
3	300 m NW	Silver maple	1.0	8.0	4.5	5.1	2.4
4	480 m NW	Silver maple	3.5	3.0	1.6	1.3	1.0
9	370 m N	Elm**	1.9	1.4	0.6	1.0	0.4
12	200 m NE	Nor. maple**	10.0	15.0	1.5	4.0	4.8
14	500 m NE	Apple	1.9	1.9	0.6	0.7	0.6
15	745 m NE	Elm**	0.6	0.2	0.3	0.7	0.5
18	290 m E	Silver maple	9.0	18.0	2.9	5.4	5.3
19	105 m SE	Nor. maple**	NR	NR	5.9	8.6	7.1
25	240 m S	Ash	9.4	5.2	3.6	4.4	1.7
27	490 m S	Apple	3.1	1.3	0.9	1.0	0.9
28	820 m S	Apple	1.7	0.3	<0.2	0.3	0.3
29	1080 m S	Silver maple	2.5	0.9	0.3	0.8	0.3
30	230 m SW	Ash	2.3	3.4	0.8	0.7	0.9
36	350 m W	Man. maple	5.1	7.9	1.0	1.6	0.2
38	790 m W	Elm	1.1	1.3	0.3	0.6	<0.2
42	520 m N	Ash**	2.1	1.9	0.3	0.4	<0.2
45	420 m E	Elm**	1.2	7.8	<0.2	0.5	NR
49	495 m E	Honey locust	3.4	2.8	0.3	0.4	0.5
50	640 m E	Norway maple	1.1	1.9	0.3	0.4	0.2
51	820 m E	Elm	1.7	2.2	0.2	0.6	0.2
52	895 m E	Norway maple	0.4	0.2	<0.2	0.3	<0.2
54	615 m E	Norway maple	2.0	2.0	0.2	0.8	<0.2
55	895 m E	Nor. maple**	1.1	0.2	<0.2	0.3	<0.2
56	1095 m E	Norway maple	0.9	0.2	<0.2	0.4	0.2
57	1210 m E	Sugar maple	0.2	0.3	<0.2	0.3	<0.2
58	510 m E	Silver maple	5.7	2.5	0.6	1.3	0.6
59	610 m E	Norway maple	3.0	1.2	0.2	0.5	0.5
60	650 m SE	Silver maple	3.1	2.6	0.6	0.5	0.5
61	830 m SE	Norway maple	1.3	0.8	<0.2	0.3	0.2
62	960 m SE	Norway maple	0.7	0.3	<0.2	0.3	<0.2
64	480 m SE	Norway maple	2.4	1.8	0.3	0.6	0.3
65	570 m SE	Sugar maple	2.0	1.0	0.4	0.8	0.3
66	600 m S	Ash	1.0	0.3	<0.2	0.4	0.2
67	775 m S	Norway maple	1.0	0.4	0.2	0.5	0.2
68	350 m SE	Ash	5.4	5.7	0.6	1.2	0.9
71	630 m S	Apple	1.6	0.4	0.3	0.3	<0.2
72	840 m S	Man. maple	0.3	0.4	<0.2	0.3	<0.2
73	575 m SW	Norway maple	NR	0.3	<0.2	0.3	<0.2
74	910 m E	Silver maple	NR	0.5	0.2	0.5	<0.2
		Analytical Detection Limit	0.2				

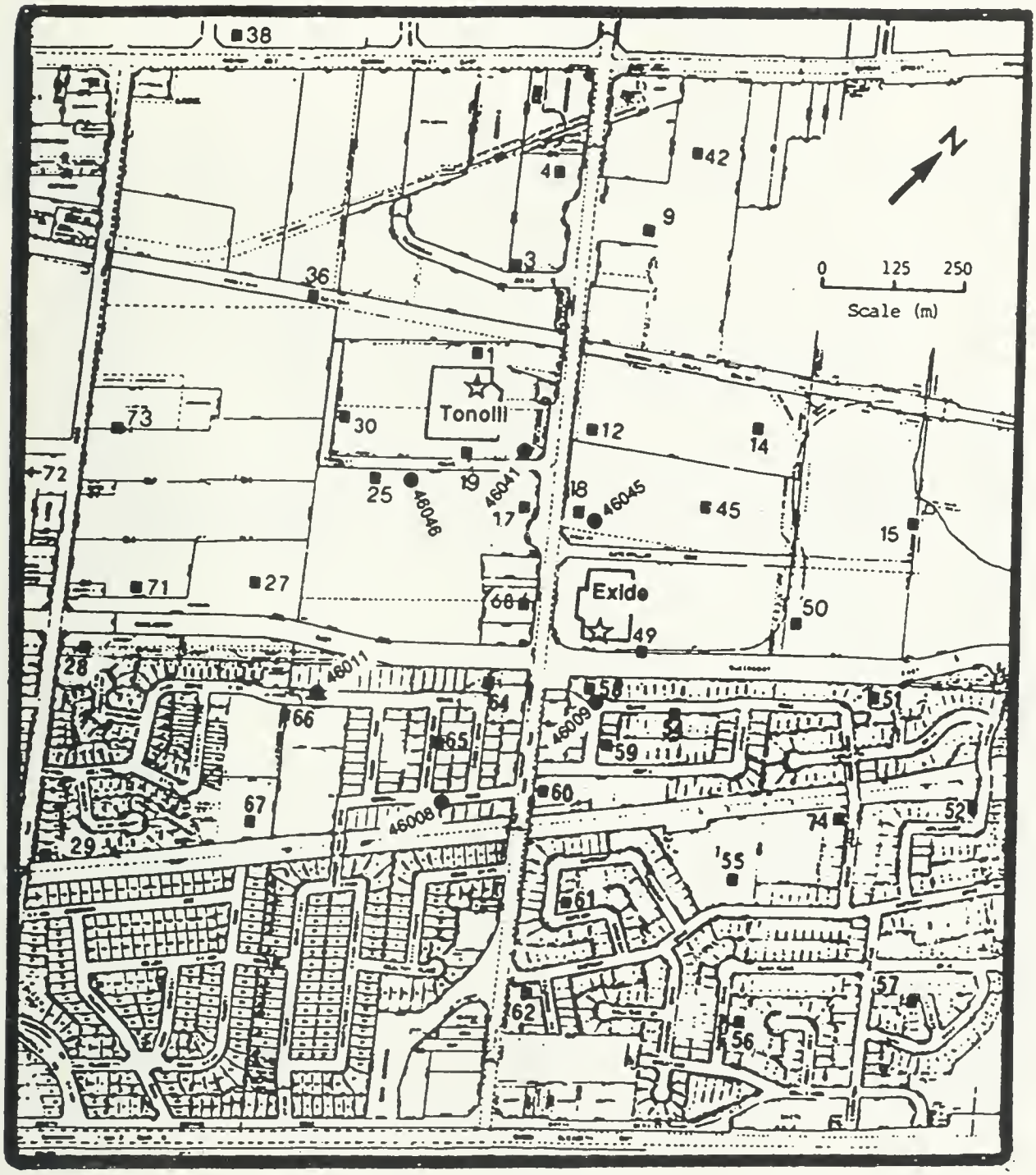
* ug/g, dry weight, mean of duplicate (1987-1991) samples and analysis. Single samples were collected in 1986
** different species sampled prior to 1989
NR - not sampled
Note: Values underlined exceed Phytotoxicology "Upper Limit of Normal" urban guideline (0.5), see appendix
Nor = Norway, Man = Manitoba

Table 5: Concentrations of Lead, Arsenic, Antimony and Cadmium in Austrian Pine Needles Collected Between Tonolli and Exide, Mississauga: 1977, 1983 - 1987

Site and Side Sampled	Annual Concentration* in Current Year Needles											
	1977	1983	1984	1985	1986	1987	1977	1983	1984	1985	1986	1987
	Lead						Arsenic					
Site 19												
Facing Tonolli	707	280	320	1130	880	720	10.9	1	2	3.6	2.7	3.6
Facing Exide	214	243	200	675	300	210	3.2	0.5	0.7	1.6	0.9	0.6
Site 17												
Facing Tonolli	276	243	325	405	310	220	7.4	0.5	0.8	1.3	1.3	1.3
Facing Exide	111	167	125	215	170	110	1.9	0.4	0.3	0.5	0.4	0.3
	Cadmium						Antimony					
Site 19												
Facing Tonolli	1.3	0.8	1.0	0.8	0.4	0.4	NR	5.1	16.9	17.8	15.0	19.0
Facing Exide	1.0	0.6	0.4	0.6	0.3	0.4	NR	2.1	2.7	8.1	5.0	3.8
Site 17												
Facing Tonolli	0.8	0.6	0.2	0.6	0.3	0.3	NR	2.2	6.2	6.5	5.2	6.7
Facing Exide	0.6	0.4	0.2	0.4	0.2	0.2	NR	1.5	1.7	1.6	2.2	2.3

* ug/g, dry weight, mean of replicate samples and analysis
Site 19 pine was located 160 m southeast of Tonolli and 370 m west of Exide
Site 17 pine was located 220 m east of Tonolli and 260 m west of Exide

Figure 1: Foliage Collection Sites And Air Monitor Stations in Area of Tonolli



● Dustfall - Stations 46008, 46009, 46011, 46041, 46045, 46046 ● Hi-Vol - Stations 46041, 46045, 46046
■ Foliage Collection Site

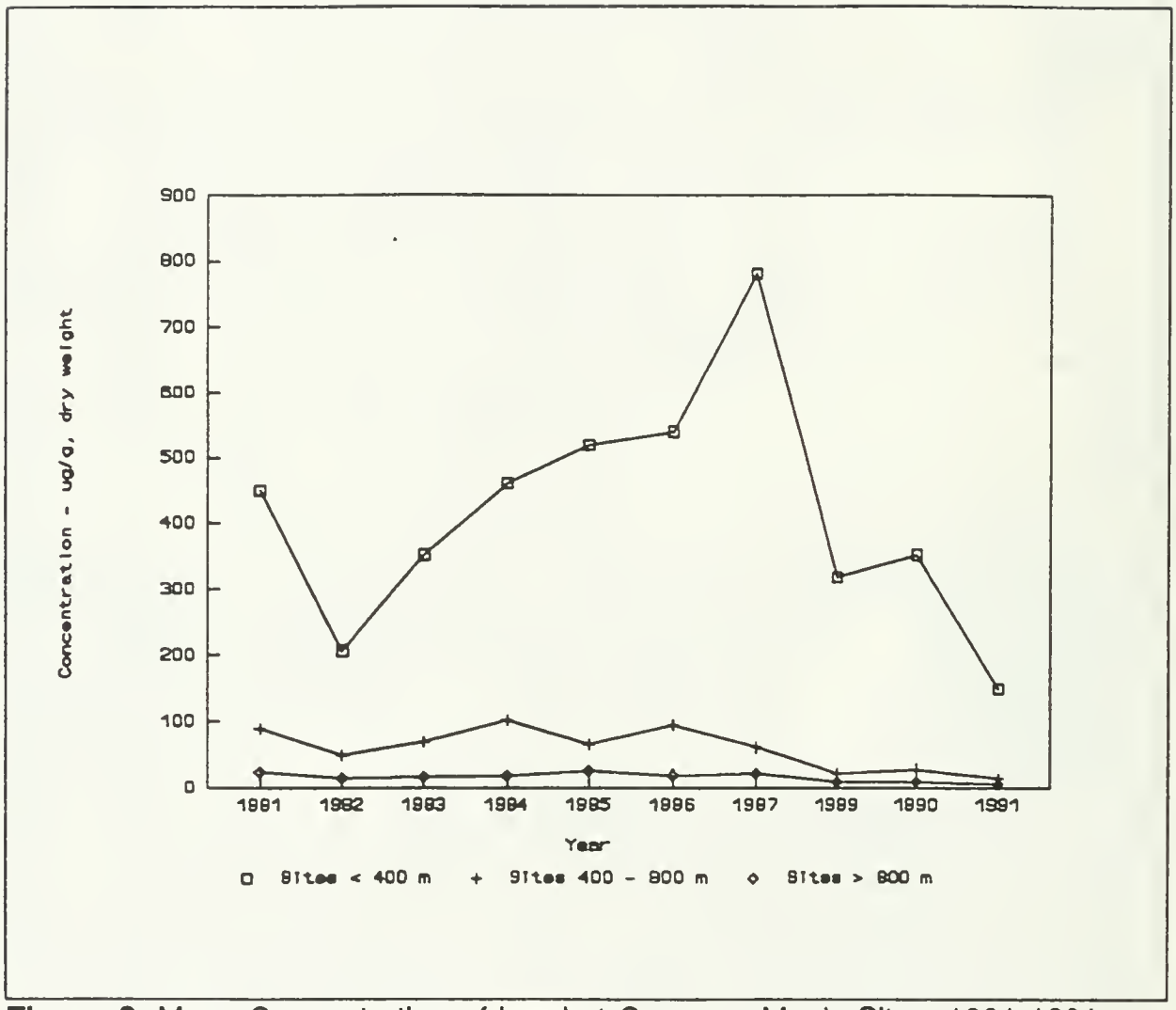


Figure 2: Mean Concentration of Lead at Common Maple Sites: 1981-1991

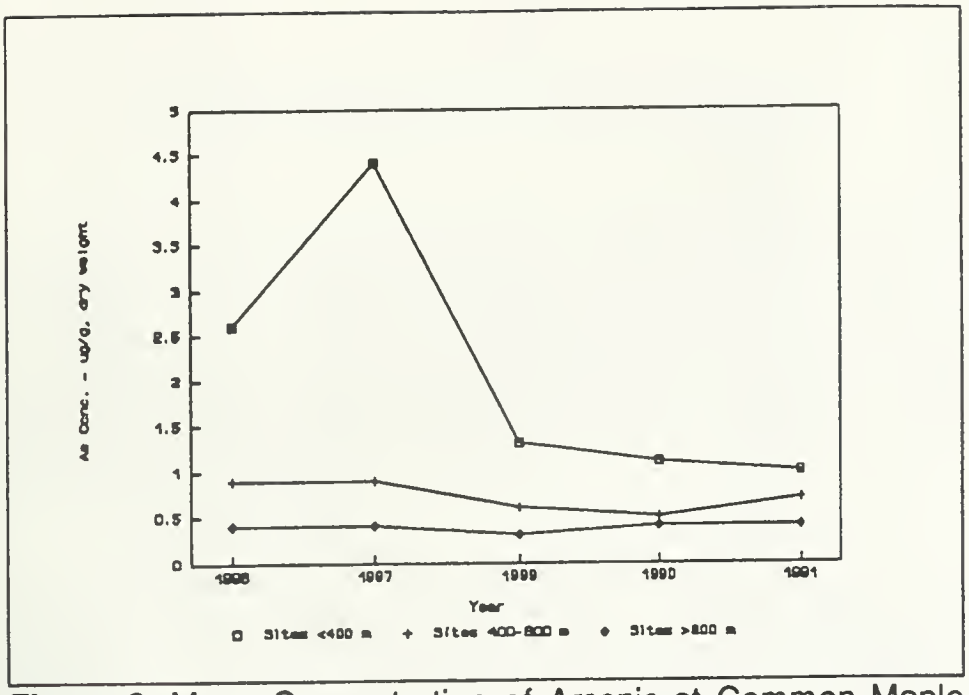


Figure 3: Mean Concentration of Arsenic at Common Maple Sites: 1986-1991

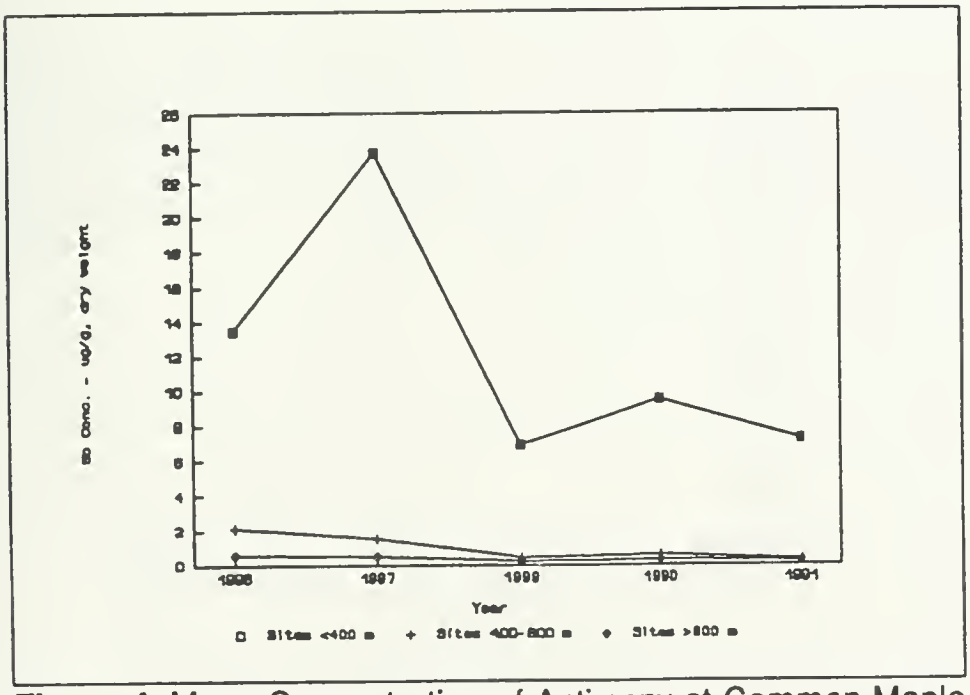


Figure 4: Mean Concentration of Antimony at Common Maple Sites: 1986-1991

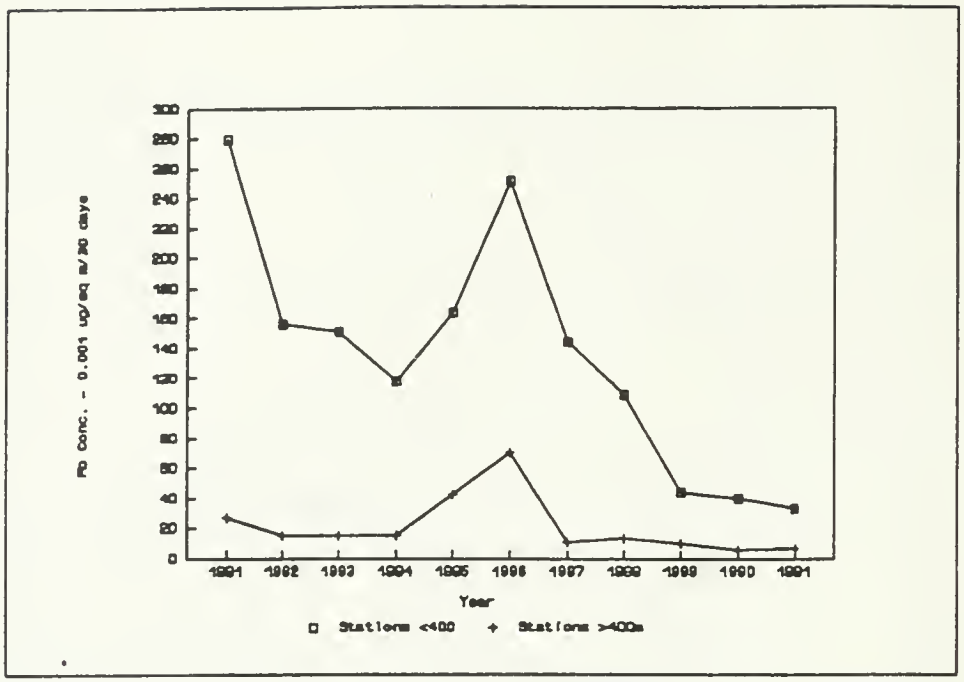


Figure 5: Annual (June-September) Mean Lead Concentration in Dustfall: 1981-1991

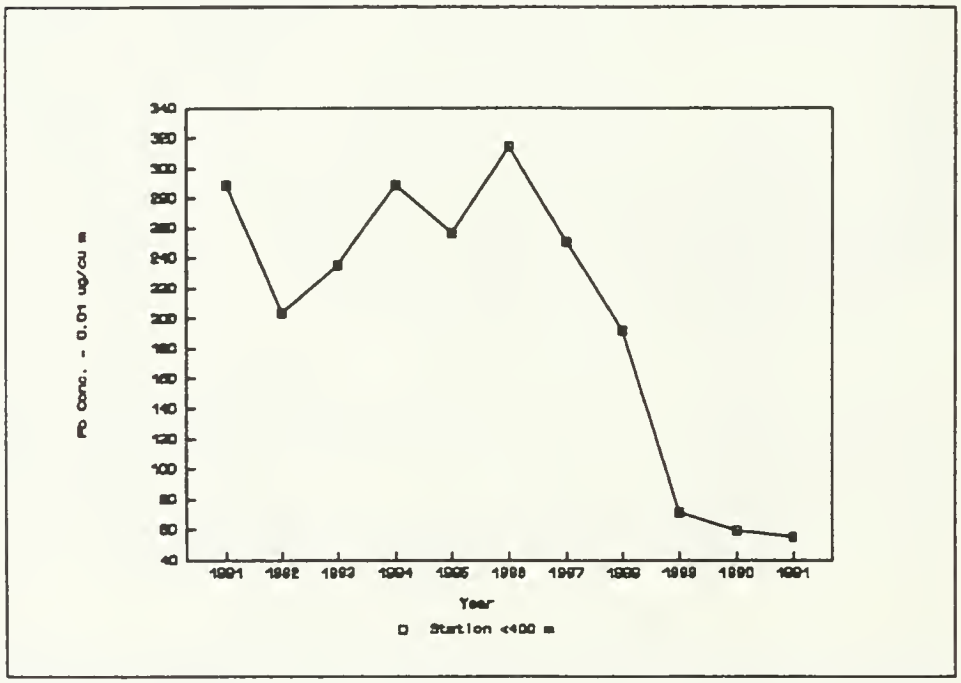


Figure 6: Annual (June-September) Mean Lead Concentration in Suspended Particulate: 1981-1991

APPENDIX

Derivation and Significance of the MOE Phytotoxicology "Upper Limits of Normal" Contaminant Guidelines.

The MOE Upper Limits of Normal (ULN) contaminant guidelines represent the expected maximum concentration in surface soil, foliage (trees and shrubs), grass, moss bags, and snow from areas in Ontario not exposed to the influence of a pollution source. Urban ULN guidelines are based on samples collected from urban centres, whereas rural ULN guidelines were developed from non-urbanized areas. Samples were collected by Phytotoxicology staff using standard sampling procedures (reference: Ontario Ministry of the Environment 1992, Phytotoxicology Field Investigation Manual). Chemical analyses were conducted by the MOE Laboratory Services Branch.

The ULN is the arithmetic mean plus three standard deviations of the suitable background data for each chemical element and parameter. This represents 99% of the sample population. This means that for every 100 samples that have not been exposed to a pollution source, 99 will fall within the ULN.

The ULNs do not represent maximum desirable or allowable limits. Rather, they are an indication that concentrations that exceed the ULN may be the result of contamination from a pollution source. Concentrations that exceed the ULNs are not necessarily toxic to plants, animals, or people. Concentrations that are below the ULNs are not known to be toxic.

ULNs are not available for all elements. This is because some elements have a very large range in the natural environment and the ULN, calculated as the mean plus three standard deviations, would be unrealistically high. Also, for some elements, insufficient background data is available to confidently calculate ULNs. The MOE Phytotoxicology ULNs are constantly being reviewed as the background environmental data base is expanded. This will result in more ULNs being established and may amend existing ULNs.